FOREST SCIENCE PROGRAM ANNUAL REPORT 1998/99

science to support sustainability

98|99

BRITISH COLUMBIA
Ministry of Forests

"TO HELP PROVIDE INNOVATIVE SOLUTIONS TO HIGH-PRIORITY FOREST MANAGEMENT PROBLEMS IN BRITISH COLUMBIA AND TO ADVANCE RESOURCE STEWARDSHIP BASED ON SCIENTIFIC PRINCIPLES"

Measuring turbidity in water samples collected in an automatic sampler

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JOINT MESSAGE FROM THE CHIEF FORESTER AND THE ASSISTANT DEPUTY MINISTER, OPERATIONS

More details about Research Branch and regional Forest Science activities, including publication lists, downloadable reports, and current events and projects, are available on the Forest Science Program website at: www.for.gov.bc.ca/research

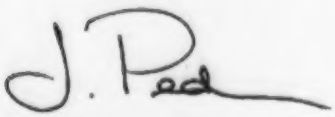
The Forest Science Program is an important expression of the Ministry of Forests' commitment to seek innovative solutions to the complex forest management challenges in British Columbia. This annual report provides an overview to senior managers in government, industry and forest agencies, and to stakeholders and the public about the performance of their investments in the program. The report informs a wide readership – locally, nationally and internationally – about forest science activities that are being carried out in the Forest Science Program.

After an eight-year hiatus following the 1991/92 *Research Program Annual Review*, this report presents current work and acts as a bridge to work done in the recent past. It emphasizes results of the Forest Science Program and their application to forest and range resource management in B.C. A feature of this and future reports will be to showcase topical areas of research being done by the Forest Science Program; this year's report highlights three integrated research sites where silvicultural systems are being studied.

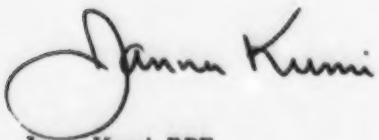
Research Branch and regional forest science staff play a unique role on the front lines of policy development and operational forest and range resource management. Through teamwork and partnerships with other forest science groups, they add external resources to their own capabilities in addressing the province's high-priority needs and opportunities. We rely a great deal on the credible technical and professional advice and information that our science staff provide – everything from managed stand yield estimates for

the Timber Supply Review, to expert opinions on watershed assessment procedures, stand density management guidelines, and weight scale sampling.

Forest management today is complex, and subject to ever-increasing demands from multiple interests, all of whom have dramatically different visions of how forests should be used, managed and conserved for the public. We look to our researchers and technical specialists, working in close cooperation with their counterparts in academia, other agencies and the private sector, to provide new insights and innovative solutions to help the forest sector move forward successfully into the new millennium.



Larry Pedersen, RPF
Chief Forester
Assistant Deputy Minister
Forestry Division



Janna Kumi, RPF
Assistant Deputy Minister
Operations Division

OVERVIEW OF THE FOREST SCIENCE PROGRAM

THE SCIENTIFIC FOUNDATION OF FOREST MANAGEMENT

The Earth Summit in Rio de Janeiro in 1992 focused world attention on forest ecosystems and promted international consumer activism over issues such as clearcutting and logging old growth. Since then, the number of forest and range resource issues has increased dramatically. Certification and other market-driven international pressures constantly emphasize the need to balance economic development with sound forest stewardship.

The development and implementation of the Forest Practices Code in B.C. spoke directly to that need. Initiatives such as the Commission on Resources and Environment, the Old-Growth Strategy Project, the Clayoquot Sound Scientific Panel, and the Timber Supply Review have addressed other emerging forest-sector issues in the past decade. New demands for knowledgeable input continue to arise as the ministry rebalances its priorities to maintain jobs in the forest sector, promote long-term forest and range resource sustainability, and fulfill its external partnership responsibilities.

Forest Science Program staff have been deeply involved in these diverse issues, through continuing to assess and refine management practices. This work helps sustain a high-quality timber supply and meet biodiversity and integrated resource management objectives.

SUPPORTING MINISTRY OF FORESTS STRATEGIC PRIORITIES

The Ministry of Forests' mandate is to manage and protect B.C.'s timber, range and outdoor recreation resources for the best short- and long-term balance of economic, social and environmental benefits for all British Columbians. Its near-term strategic priorities[1] are to

[1] *Ministry of Forests, Five Year Forest and Range Resource Program, 1998-2003 (Victoria, August 1998).*

encourage maximum resource productivity, manage the resources responsibly, practise planned, integrated resource management and use, encourage a globally competitive forest industry, and assert the financial interest of the Crown. Its current priorities and initiatives include leading the evolution of the Forest Practices Code, and meeting the ministry's commitment, under the Jobs and Timber Accord, to introduce measures to reduce logging costs while maintaining environmental standards.

In support of the ministry's mandate and near-term priorities, the Forest Science Program continues to invest a significant portion of its resources in expanding the knowledge base for production, sustainable management, and administration of timber supplies. Program researchers also work to refine models and analytical procedures that will improve predictions of the resource-production implications of different management options.

The program has increased understanding of how integrated management prescriptions can be achieved, and how the results will affect forest growth and yield. Work in forest genetics and silviculture has revealed new ways to achieve higher productivity in future stands. In addition, research has assisted in the design of management prescriptions that are needed to achieve a variety of resource management objectives across the land base.

To support the ministry's current priorities and initiatives, Forest Science Program researchers have played important roles in the development of sections of the *Forest Practices Code of British Columbia Act*, and in monitoring on-the-ground results. Researchers were instrumental in supplying information to help establish forest practices standards, and they will continue to make significant contributions as the code is updated and refined to more effectively meet environmental goals and minimize economic impacts.

Research staff also made important contributions to the development of the Forest Practices Code itself, providing a scientific foundation for practices related to hydrology, soils, terrain stability, and ecosystem and density management. They have played a lead role in producing many code guidebooks and training packages, and were major contributors to a number of others.

Enhanced Forest Management Pilot Projects

Enhanced Forest Management Pilot Projects are designed to develop local forest management strategies that realize the full growth capability of the productive forest land base, within the context of existing land-use plans and the Forest Practices Code. Forest Science Program staff bring experience and knowledge of ecology, biology and wildlife habitat to the following pilot project sites:

- Invermere Forest District in the White/Lussier River drainage (260,000 hectares),
- MacMillan Bloedel[2] Tree Farm Licence 39, Block 6, northeast coast of Vancouver Island (208,042 hectares), and
- Babine Forest Products, in the Lakes Timber Supply Area, Prince Rupert Forest Region (379,000 hectares).

For more details about Enhanced Forest Management Pilot Projects, visit: www.for.gov.bc.ca/cpp/enhanced/index.htm

[2] *Now Weyerhaeuser Canada Ltd., Coastal Operations.*

Research Branch staff continue to provide essential support for the chief forester in the Timber Supply Review process and decisions, principally by developing growth and yield models.

CLIENTS AND PARTNERS

The Forest Science Program's primary clients are internal: they include the ministry executive and senior management, professional and technical specialists, and operational staff at all levels. Other clients are external: they include licensees, other research organizations, public agencies, private industry, and the public.

To fulfill their mandate to support ministry priorities, Forest Science Program staff balance client requests for short-term problem solving and advisory services with the ministry's corporate need to anticipate and address emerging issues and opportunities. Research activities are also influenced by scientific partnerships and the availability of external funding. For those reasons, the program has developed the capability to respond to a broad range of client demands, from information and technical advice, to the design and implementation of rigorous research projects.

The Ministry of Forests is a major partner in two external partnerships: the Southern Interior Forest Extension and Research Partnership and the Northern Forest Research and Extension Partnership. Both are working to incorporate research results into operational practice, improve information sharing, and build cooperation among research organizations and the resource management community. Partners are drawn from government agencies, industry associations, natural resource companies, First Nations groups, non-governmental organizations, Forest Renewal BC, and colleges and universities.

Spatial Timber Supply Analysis

In timber supply analysis in B.C., two broad classes of computer models are used to project harvest levels. "Spatially explicit" models rely on detailed maps of roads and future logging operations to depict cutblock harvesting over the landscape over time. "Spatially implicit" models mimic spatial effects (i.e., they ensure that cutblocks are spread out over the landscape over time) by applying broad sets of rules.

Research Branch led a special project to evaluate the relative merits of both types of timber supply models. The study concluded that although spatially explicit models incorporate much more detail, timber supply projections can diverge greatly, depending on the assumptions of the model. Spatial models, and the data on which they are based, require further refinements before they can be used to conduct the complex, extensive analysis necessary to support allowable annual cut (AAC) determinations.

SETTING PROGRAM PRIORITIES

A number of committees, advisory boards, and partnerships have been established to promote and coordinate research in the forest sciences in British Columbia. The organizations that are most significant in guiding the priorities and direction of the Forest Science Program are the Forest Science Board and advisory groups. The Forest Science Board is an internal, inter-divisional body that is co-chaired by the executive director, Operations Division, and the deputy chief forester, Forestry Division. The board reviews the annual plans and performance of the Forest Science Program – which includes reviewing proposed priorities and maintaining balance between short- and long-term research, and between its research and extension functions – then makes recommendations to the respective assistant deputy ministers. The director of the Research Branch provides Forest Science Program leadership and presents both branch and regional forest science accomplishments to the board.

Regional Forest Science Advisory Groups, which take various forms, focus on regional operational needs and priorities. The headquarters advisory process is delivered informally, through an ongoing, close working relationship between Research Branch managers and client managers in other branches.

ACCOUNTABILITY

Forest Science Program managers are primarily accountable to their senior manager clients in the Ministry of Forests for the selection of research topics and the assignment of staff and funds. This accountability occurs in the regions through Regional Management Teams, in Research Branch through the Forestry Division Management Team, and provincially through the Forest Science Board.

In some cases, such as forest productivity and genetics research, the chief forester has established stakeholder councils to provide him with advice on strategic directions and business priorities. These councils, and external funding sources such as Forest Renewal BC, also expect accountability from their partners, including ministry science staff.

Setting Science Priorities

To establish program priorities, the ministry's Forest Science Program relies on a range of client advisory processes. Sources include:

- councils (e.g., the Forest Genetics Council, the Science Council of BC, and the Forest Productivity Council of British Columbia),
- regular contact with headquarters branches of the Ministry of Forests and the Ministry of Environment, Lands and Parks,
- regional Forest Science Teams and ministry Operations staff, who recognize problems and extension needs by working closely with districts and licensees,
- Forest Science Advisory Groups,
- committees (e.g., Forest Practices Code Joint Management Committee, and the Committee of Forest Research Agencies of B.C.),
- technical groups (e.g., the Coastal Silviculture Committee), and
- partnerships (e.g., the Southern Interior Forest Extension and Research Partnership).

ORGANIZATION

The Analytical Chemistry Laboratory in Victoria.

The Forest Science Program consists of the Research Branch, within Forestry Division, and six regional Forest Science Teams within Operations Division. The Research Branch has 50 researchers working in a range of scientific disciplines. Regionally, 48 scientists also cover a variety of specialities and work closely with regional and district clients. Program scientists in all locations are supported by skilled technicians, extension specialists, statisticians, and computer, clerical and management personnel. Finally, the Forest Science Program receives invaluable assistance through collaborations with and contributions from staff in regional and district offices, other branches of the Ministry of Forests, and external partners.

Research Branch staff work at the Victoria headquarters office and four research stations on the coast and in the interior, in two regional and one district office, and at the University of British Columbia. Regional staff are located primarily in regional offices, with one staff member in the Fort St. John Forest District.

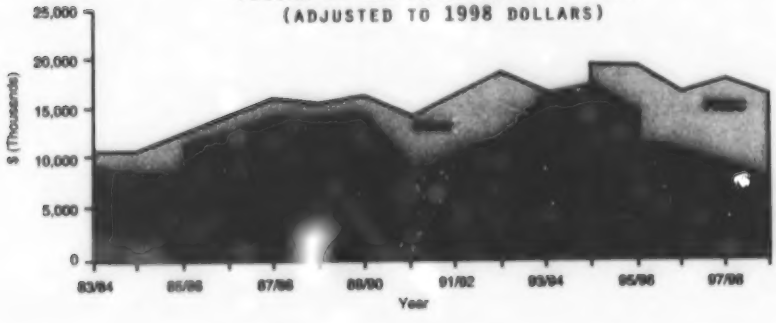
Research Branch researchers work closely with policy-makers and the ministry executive at headquarters to help provide a science foundation for policy development. Together with regional researchers, they provide technical support to regional and district staff to help them resolve complex operational issues associated with Forest Practices Code interpretation and implementation, silviculture, growth and yield, and timber supply. Regional scientists also advise on emerging front-line issues and work on innovative research, often in partnership with the Research Branch, licensees, universities, the Canadian Forest Service, and others.

FOREST SCIENCE FUNDING

Ministry of Forests funding for the Forest Science Program has historically been supplemented by external sources, including joint federal/provincial forestry programs and Forest Renewal BC. In general, voted funds cover mainly essential fixed costs (i.e., most staff salaries, facilities maintenance, and minimal operating funds), while external sources have contributed the majority of the program's operating funds since about 1985. Figure 1, below, illustrates the breakdown of funding sources for the Research Branch – not for the entire Forest Science Program – between 1983 and 1999. Despite the significant fluctuations in financial support from different sources, as shown, total funding for research increased steadily through the 1980s and early 1990s.

From 1985 to 1996, two major federal/provincial agreements made substantial contributions to forestry-related research: the Canada – B.C. Forest Development Agreement (FRDA I), and the Canada – B.C. Partnership Agreement on Forest Resource Development (FRDA II). Forest Renewal BC (FRBC) commenced its funding in 1994/95. The "Other"" category in Figure 1 includes funding from the Intensive Forest Management Subsidiary Agreement (IFMSA), the South Moresby Forest Replacement Account (SMFRA), the Forest Renewal Plan, bridging funds from FRDA, and other external sources.

FIGURE 1: RESEARCH BRANCH FUNDING
(ADJUSTED TO 1998 DOLLARS)



Includes only funding sources for Research Branch. Funding sources for the regions are not included, but sources of funding and funding fluctuations followed similar patterns.

The provincial Forest Science Program supported the equivalent of 208 full-time positions in 1998/99, split among regional offices (27%), Research Branch headquarters (47%), and Research Branch decentralized facilities (26%). Forty of these positions were funded by Forest Renewal BC.

EXPENDITURES

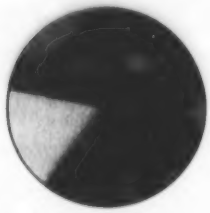
Forest Science Program expenditures in 1998/99 were divided between research and extension activities (84%) and management and support services (16%). Research and extension includes formal experimentation as well as active consultation and training for operational field staff. Support services include administration, research facilities (i.e., research stations and the Research Branch Laboratory), and specialized expertise (e.g., in biometrics and climatology) that is required by program activities.

Research priorities vary markedly between the Research Branch and the regions (Figure 2). In the provincial aggregate, however, there is an even distribution of effort among the five main research activities.

Regional resources are generally concentrated on local operational issues, such as ecosystem management, watershed protection, terrain stability (included under "Earth Sciences"), and demonstration and testing of silvicultural systems. Priorities vary significantly between one region and another, reflecting differences in the needs of the clients. Substantial portions of Research Branch expenditures go to programs that are more provincial in scope, such as growth and yield, genetics, and tree improvement (included under "Forest Genetics"). As well, activities in ecology, silviculture, and the earth sciences are undertaken by both the regions and the Research Branch to support policy development and resource management.

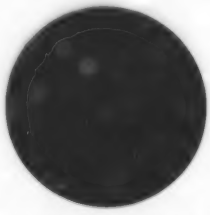
In addition to work undertaken within the Forest Science Program, an estimated $1.5 million was expended during 1998/99 on research conducted by other parts of the Forest

FIGURE 2: 1998/99 FOREST SCIENCE PROGRAM EXPENDITURES



TOTAL FOREST SCIENCE PROGRAM, $23.9M

RESEARCH BRANCH, $16.7M



REGIONAL RESEARCH, $7.2M

Service (e.g., by Forest Practices Branch and Resources Inventory Branch, among others). Details of those expenditures and accomplishments are not included in this annual report.

FUNDING TRENDS

Low-productivity coastal forest

Despite the fact that the Forest Science Program derives a significant portion of its funding from external sources, it currently faces the same downward pressures on budgets and staffing levels which affect the rest of the Ministry of Forests. Base funding for the entire Forest Science Program decreased from $14.1 million in 1997/98 to $12.1 million in 1998/99. As a result, 11% of the positions within the program were eliminated, primarily in the Research Branch headquarters office.

Forest Renewal BC has been the major external funding source for the ministry's Forest Science Program since 1995/96. It contributed $10.3 million from its Research Program funds in 1998/99, and currently supports active research projects, with associated salaries, representing 19% of ministry Forest Science Program staff positions. An additional $2.7 million was provided in 1998/99 by other Forest Renewal BC programs (e.g., the Operational Tree Improvement Program).

Forest Renewal BC Research Program funding commitments for ministry projects will be $6.4 million in 1999/00, $5.6 million in 2000/01, and $0.3 million in 2001/02. In the absence of new revenues, Forest Science Program activities may be significantly affected.

THE FOREST SCIENCE PROGRAM IN 1998/99

SILVICULTURE

Silviculture research explores stand establishment, stand tending, and the various silvicultural systems used in British Columbia, and evaluates the benefits and impacts of those systems. Silviculture research also provides information to develop and verify growth and yield models, help district silviculturists make field decisions, and formulate regional and provincial policy. Today, because of changing forest practices, the focus has shifted to predicting the effects of management on long-term forest dynamics, especially following partial cutting where variable levels of canopy trees are retained. It has also shifted to developing mixedwood and broadleaf management strategies.

The silviculture research program currently has two goals:

- to develop better models for mixedwood and other complex stands, and
- to predict management impacts on timber supply, sustainable forest management, and a variety of other, related values such as habitat, biodiversity and recreation.

Silviculture research is carried out in six principal areas: vegetation management, growth and yield field studies, silvicultural systems, management of conifer-broadleaf mixtures (mixedwood), forest regeneration and stand tending, and the effects of insects and diseases.

Vegetation management research helps develop methods for managing vegetation which are cost-effective and environmentally sound. Researchers examine a range of practices, such as manual and biological methods and herbicide treatments, in order to acquire basic information on the effectiveness, impacts and costs of various treatments.

PROBE is a comprehensive monitoring system that is being used to evaluate operational brushing treatments on a wide range of vegetation types on more than 90 sites in the southern interior. Short-term objectives are to quantify the effects of operational brushing on the growth of conifer crop trees. Details have been published for operational foresters and publicized at Southern Interior Silviculture Committee meetings.

EXPLORE is a protocol for studies providing long-term data on the impacts of vegetation management options. This provincial protocol was developed as a joint effort by staff from Research Branch, Forest Practices Branch, and regional Forest Science sections. EXPLORE has been tested on two PROBE installations, to document potential long-term impacts of vegetation management treatments.

In addition, the Northern Interior Vegetation Management Association has developed the **TRENDS** monitoring system, which shares a number of central features with EXPLORE. The TRENDS protocol is being used by the Ministry of Forests and industry to document the benefits and impacts of early regeneration silviculture activities in the central and northern interior.

Growth and yield field studies assess growth and yield responses to various silvicultural treatments. Data are collected to measure tree and stand responses to treatments such as planting density, spacing, commercial thinning, genetic improvement, and fertilization. The information also helps researchers calibrate and validate stand models and site index curves. Past emphasis has been on even-aged treatments in coastal and interior stands, but the focus is now shifting to complex stands and partial cutting systems.

Silvicultural systems research examines alternative approaches to managing stands of trees and other vegetation over time, to meet a variety of resource-use objectives. This includes the management of complex stands, partial cutting in such stands, and general interactions between silviculture and the management of non-timber resources. Numerous short-term projects now underway in the province are addressing the urgent need for information on the techniques and effects of partial cutting (see sidebars and the case studies later in this section). Although case studies are all designed as long-term projects, they provide information in the short term to guide operational practices.

Management of conifer-broadleaf mixtures (mixedwood) is an important emerging area of research, because conifer-broadleaf mixtures represent more than one-third of British Columbia's productive forests. Understanding the ecology and silvics of all species in the mixture, including the dynamics of growth patterns and other processes, is fundamental to developing and refining policy, stand management guidelines, and mixedwood stocking standards and models.

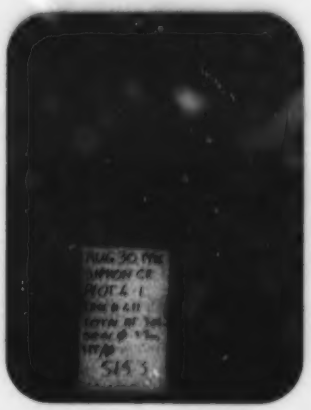
Through ***forest regeneration and standing-tending*** research, the Forest Science Program is developing management solutions for problem forest stands. Researchers are trying to learn more about these forest types (e.g., densely stocked stands in the interior, and low-productivity stands of western redcedar – yellow cedar – western hemlock on the coast). Their work includes studying the stands' site ecology, reproduction and seed biology, stock quality, ecophysiology, and establishment silviculture.

Roberts Creek Study Forest

The Roberts Creek Study Forest was established on the Sunshine Coast to demonstrate and compare a wide range of approaches for harvesting and managing lower-elevation, Douglas-fir – dominated ecosystems in the Coastal Western Hemlock Dry Maritime (CWHdm) biogeoclimatic subzones. The study forest provides extension opportunities and a place to demonstrate the operational skills required for partial cutting. Portions of the study forest are also used for hydrology research.

Weighing a snow core at the Black Bear silviculture systems research site.

Field studies on the ***effects of insects and diseases*** focus on the operational problems in managing affected stands. For example, the *Armillaria* root disease is a widespread and serious problem in southern British Columbia, and there are a number of studies underway to evaluate treatment options. Other projects are examining the impacts of partial cutting on the spread of *Armillaria*. In a cooperative project between ministry and Canadian Forest Service researchers, extensive research is also now underway on two poorly understood defoliators in northern B.C., *Choristoneura biennis* and *C. fumiferana*.



Researchers in the Prince George Region have been working closely with licensees to improve the mixedwood guidelines for northern forests. Trials that have been conducted in the past decade at Siphon Creek (near Fort St. John) and Bear Mountain (near Dawson Creek) are providing useful information on the dynamics of young spruce-aspen mixedwood stands.

Low-productivity Coastal Forests

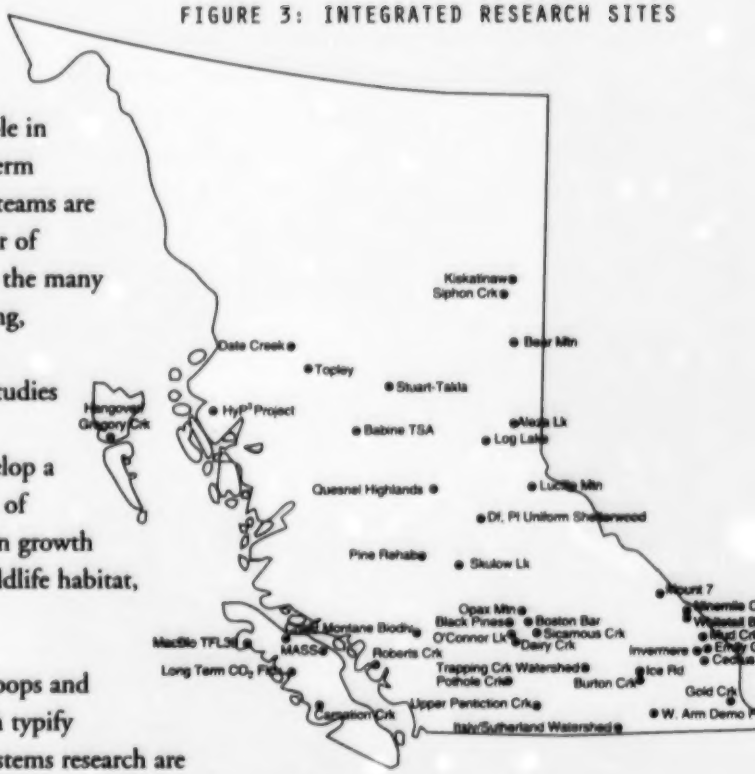
In collaboration with university and private-sector researchers, ecology researchers are leading what is called the HyP^3 Project. Initiated in 1996, it is a Forest Renewal BC project to explore the feasibility of managing low-productivity western redcedar - yellow cedar - western hemlock forests for sustainable timber production on the outer coast. These sites occupy a significant proportion of the land base on the north coast. The project is exploring the ecology, hydrology, soils and silviculture of the stands.

Overly Dense Lodgepole Pine Stands

Fire-originated, overly dense lodgepole pine stands that are more than 30 years old take up some 150,000 hectares in the central Cariboo, making them a major concern. Research staff are working with the forest industry on operational options to restore the productivity of these stands. Treatments include spacing and fertilizing the existing stands, and various stand rehabilitation measures (e.g., manually and mechanically cutting selected trees).

INTEGRATED RESEARCH CASE STUDIES – SILVICULTURAL SYSTEMS

FIGURE 3: INTEGRATED RESEARCH SITES



Silvicultural systems projects provide information that is valuable in addressing both short- and long-term resource-use challenges. Research teams are working cooperatively at a number of locations (see Figure 3) to address the many dimensions of alternative harvesting, regeneration, and management objectives. Pooling the results of studies in many disciplines at these sites, researchers and managers can develop a cohesive perspective on the effects of different silvicultural treatments on growth and yield, stand establishment, wildlife habitat, and a variety of other features.

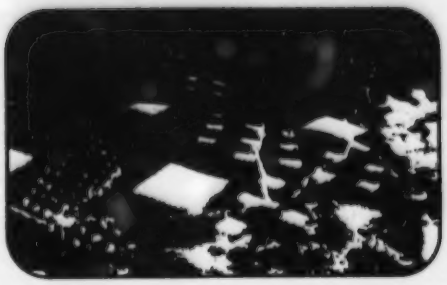
Three major projects in the Kamloops and Prince Rupert forest regions which typify Ministry of Forests silvicultural systems research are showcased in this annual report. Numerous other projects are also underway in the province to address the need for information on the impacts of partial cutting in complex stand types.

Sicamous Creek Research Project (Kamloops Forest Region)

The broad objective of the Sicamous Creek Research Project is to provide information on how to manage wet, cold, high-elevation forests in the southern interior. By evaluating ecosystem responses to different types of canopy removal and site preparation treatments, operational foresters can choose alternative methods for logging and regeneration to meet their forest management objectives.

An expected outcome of the project will be a shift in the management of high-elevation forests, from the current pattern of large-patch clearcutting, mechanical site preparation, and planting, to a broader array of logging and regeneration techniques.

The site is located in the Salmon Arm Forest District, southeast of the town of Sicamous. The forest is representative of the Engelmann Spruce – Subalpine Fir Wet Cold, Northern Monashee biogeoclimatic variant (ESSFwc2). The research site occupies 500 hectares situated on a northerly aspect at an elevation between 1,530 and 1,830 metres. The site is close to the upper limit of continuous forest (i.e., 1,900 metres). Research is also going on in 1,000 hectares of demonstration forest adjacent to the research site.



Sicamous Creek Research Project

Run by a multi-agency partnership that was formed in 1991, the project now includes more than 30 researchers.[3]

The high-elevation forest is composed of 300-year-old subalpine fir and Engelmann spruce. It is under pressure from logging and recreational users. Relatively little is known about the ecology of these forests and their response to management, and the prospect of extensive harvesting at such high elevations underscores the need for sound technical information.

Stand regeneration is fundamental to a successful silvicultural system, so experimental harvesting treatments were designed to create a wide variety of stand establishment conditions. Studies range from the interactions among wind, wind damage, local topography, micro-climate and changes in forest cover, to the impact of logging opening size on soils and soil processes, to wildlife habitat effects before and after logging. Of particular significance to forestry operations is work on windthrow, economic productivity and costs of logging, and the safety risks posed by subalpine fir snags.

Project funding is being provided by Forest Renewal BC. Funding for some projects has already ended, and funding for the overall project is scheduled to end by March 2001. Project website: www.for.gov.bc.ca/research/kamloops/siccreek.htm

Date Creek Experimental Forest (Prince Rupert Forest Region)

What are the effects of management practices on the long-term dynamics of northern temperate forests? How can those effects be reliably predicted? Researchers at the 4,000-hectare Date Creek

[3] *Participants in the project represent the Salmon Arm Forest District, Riverside Forest Products Ltd., the Kamloops Forest Region, Research Branch, Forest Engineering Research Institute of Canada (FERIC), the Canadian Forest Service, Okanagan University College, the Royal British Columbia Museum, Simon Fraser University, the University of British Columbia, the University College of the Cariboo, the University of Helsinki, and the University of Victoria.*

Experimental Forest in the Prince Rupert Forest Region are involved in an integrated program of modelling and empirical studies to answer those questions.

The Prince Rupert Forest Region has been conducting silviculture research since the early 1940s, and there are currently more than 30 active projects that have been running for longer than 15 years. Date Creek, located in the transitional coast-interior forests (i.e., in the Interior Cedar-Hemlock [ICH] biogeoclimatic zone) of northwestern B.C., is one of the areas with the most concentrated research.[4]

Forests in the research area contain a mix of conifer and broadleaf tree species. Mature forests (i.e., 130 to 140 years since fire) are dominated by western hemlock, but are intimately mixed with western redcedar, subalpine fir (or amabilis fir at higher elevations), lodgepole pine, hybrid spruce, paper birch, trembling aspen, and black cottonwood. In the old-growth stands (i.e., 350 years since fire), western hemlock dominates other, minor-component species. In part, the Date Creek site was chosen for its wide range of tree and wildlife species, which allows for a wider extrapolation of results to both coastal and interior forests. The ICH forests are also generally well suited to both partial cutting and clearcutting.

The Date Creek Silvicultural Systems Study was established in 1992 to examine two levels of partial cutting, plus clearcut areas and undisturbed forest. Four stands with different structures were created to provide a wide variety of environmental conditions. In the light partial cutting treatment, approximately 30% of the stand volume was removed either by cutting single stems or creating small gaps (i.e., three to 10 trees). In the heavy partial cutting treatment, approximately 60% of stand volume was removed by cutting large gaps (i.e., 0.1 to 0.5 hectare), evenly distributed across the treatment units.

Results indicate that a range of harvest intensities, instead of a uniform management approach, maintains greater habitat diversity for a number of species, and reduces impacts on timber production. These findings

[4] *All research disciplines from the ministry's Smithers office have been involved in Date Creek projects, as have researchers from the Research Branch, the Forest Engineering Research Institute of Canada (FERIC), the Institute of Ecosystem Studies in New York, Michigan State University, the University of Northern British Columbia, Yale University School of Forestry, Okanagan University College, the University of British Columbia, Canadian Forest Service, Simon Fraser University, and the private sector.*

are now being applied at the landscape level through the Small Business Forest Enterprise Program in the Kispiox Forest District.

The Date Creek area is also actively used for extension and demonstration. Participants in 1998 field tours included members of the local community (including First Nations), visiting researchers, the Forest Renewal BC Environment Committee, professional foresters, agrologists and biologists, students, and Minstry of Forests management.

Results of studies are available at two websites:

- 'Date Creek' at www.for.gov.bc.ca/prupert/research
- www.pfc.cfs.nrcan.gc.ca/practices/ferns.htm (the Forest Ecosystem Research Network of Sites, or FERNS) to access a range of Canadian silvicultural systems studies.

Pothole Creek Study Area (Kamloops Forest Region)

The interior drybelt Douglas-fir forests (i.e., in the Interior Douglas-fir [IDF] biogeoclimatic zone) have a long, albeit irregular, history of uneven-aged management. For that reason, they offer opportunities for retrospective study of uneven-aged tree growth and stand dynamics. Appropriate management of these forests, and their contribution to the timber supply, are also topics of considerable debate in the southern interior, so pressure is increasing for improved site-specific growth and yield estimates.

The Pothole Creek Study Area, which was established in the fall of 1996, is located about 30 kilometres southeast of Merritt, B.C., in a 5-hectare, pure Douglas-fir stand composed of three main age classes (i.e., 30, 110 and 210 years). The area was chosen for growth and yield research because it is relatively undisturbed by insects or disease. It is typical of large areas of IDF forest in the Merritt Forest District that were partially cut in the 1960s, and for which very little growth and yield information is available. The study area is part of the larger Pothole Creek Demonstration Area, in which innovative silviculture and inventory methods are being developed.

Models such as Tree and Stand Simulator (TASS) and Prognosis^{BC}, which project complex stand growth and yield, have been under development for some time, but there are few long-term studies of

stands to support traditional data modelling approaches. To adequately evaluate and improve these models, a better understanding is needed of the biology and dynamics of tree growth in complex stands.

At Pothole Creek, researchers[5] are pursuing an integrated series of observational, exploratory, and longer-term projects in subject areas such as:

- mensuration, growth and yield,
- canopy modelling and stem analysis,
- regeneration and seed dispersal,
- light relationships,
- tree physiology and moisture relations,
- root dynamics, and
- coarse woody debris.

Site tour for operational foresters at the Pothole Creek Study Area.

Researchers at the Pothole Creek site are cooperating with those working at the Kamloops Forest Region's Opax Mountain site, and at several locations in the Cariboo Forest Region. Papers were published in 1998 from a workshop that was held to bring together researchers working in the IDF forest.

The results of these studies have already been used to help clarify the growth projection issues associated with uneven-aged stands, and will be directly applied to developing and testing complex stand growth and yield models. They will help the chief forester determine allowable annual cuts in areas where partial cutting systems are used more extensively. Through cooperation between the Merritt Forest District and Weyerhaeuser Canada Ltd., the information can also be integrated with the larger-scale projects – examining innovative silvicultural systems and inventory methods for IDF forests – that have been established in the surrounding Pothole Creek Demonstration Area. Forest Renewal BC is funding most of the work at both the Pothole Creek Study Area and the demonstration area.

Tours of the site and other presentations for operational and scientific audiences have been conducted regularly since 1996.

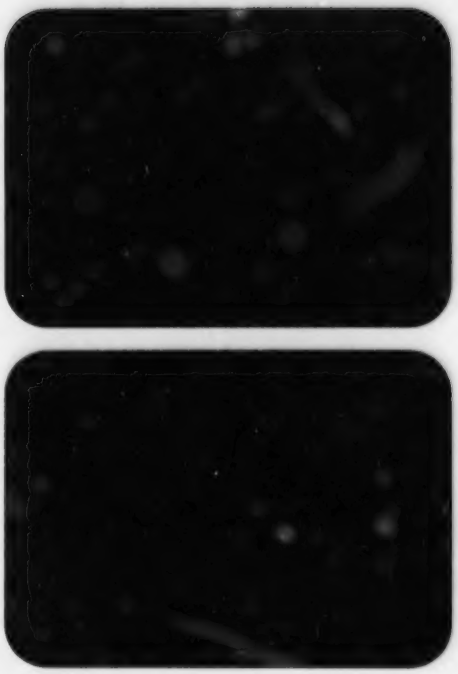
Detailed summaries of each of these projects, as well as some preliminary results, are available on the Pothole Creek Study Area website (www.for.gov.bc.ca/research/pothole), and in Ministry of Forests Research Program Working Paper 38, 1999, "Historical Fire Regime for the Pothole Creek Interior Douglas-fir Research Site."

[5] *Researchers represent the ministry's Research Branch and the Kamloops Forest Region, the University of Victoria, Yale University, and the Danish Forest and Landscape Research Institute.*

GROWTH AND YIELD

Growth and yield research, which develops and calibrates models of forest growth and yield under various management regimes, directly supports the chief forester's responsibility for allowable annual cut (AAC) determinations. This research also provides essential information and tools for silvicultural treatments and investment decisions by field staff. The research is integrated with related activities in other Ministry of Forests branches, including Resources Inventory, Forest Practices, and Timber Supply.

The Forest Productivity Council of British Columbia provides direction on short- and long-term priorities for both of the major components of the program: site productivity research, and stand modelling.



Tree and Stand Simulator (TASS)

The inherent ***productivity of a site***, which is estimated using a site index, is probably the single most important factor affecting future stand yields and long-term timber supply from our forests. Therefore, accurate assessments of site productivity are essential in making decisions about AACs and silvicultural investments. To fulfill these needs, researchers have, for a number of years, been developing improved site index functions, growth intercept equations, site index conversion equations, and years-to-breast-height equations. That work continues, but over the past several years, the emphasis has been on estimating site productivity for very young and older stands, and for complex stands.

The Timber Supply Review (1992 to 1996) raised the concern that old-growth site productivity estimates based on inventory information may have underestimated the actual growth potential of these sites after they are harvested and replaced with managed second-growth stands. This concern led to the Old-Growth Site Index Project (OGSI). Future work will determine whether adjustments are needed for other stand ages, and to estimate site productivity for complex stands. Work will also continue on longer-term solutions, such as the Site Index Biogeoclimatic Ecosystem Classification (SIBEC) project, for estimating site productivity.

Stand modelling provides tools that help predict the impacts of site factors, stand conditions, pests, and silvicultural treatments on the growth, yield and value of managed stands. Work is continuing to improve current ministry growth and yield models, such as the Tree and Stand Simulator (TASS), the Table Interpolation Program for Stand Yield Information (TIPSY), Site Tools, and Silviculture on Yield, Lumber Value and Economic Return (SYLVER). Recent efforts have examined the impacts of repression in lodgepole pine, the impacts of snags, and the effects on forest yield of silvicultural practices such as fertilizing, commercial thinning, and the use of genetically improved stock.

Until several years ago, the primary focus was on relatively simple stand structures (i.e., even-aged managed stands with only one or a few species present). However, with increased interest in partial cutting and in managing stands with multiple ages and species, the emphasis has now shifted to producing tools for use in complex stands. Field data collection efforts are currently underway on mixed-species stand dynamics in the ICH and IDF zones (e.g., in the Pothole Creek Study Area in Merritt), so that TASS can be extended to complex stands.

The ministry is also working on a number of other models:

- The first version of Prognosis^{BC} gives researchers quicker access to a usable yield model for interior stands, and is easier to tie into inventory data, but it is not as robust as TASS.
- Work continues on calibration of SORTIE-BC for the mixed-species forests of northern British Columbia. SORTIE is a spatially explicit forest dynamics model that was originally developed in the eastern

Old Growth Site Index

The Old Growth Site Index Project (OGSI) (1994 to 1998), which was funded by Forest Renewal BC, compared site index estimates for older stands with estimates from younger stands growing on the same types of sites. Subsequent site index adjustments indicate that the site index for some second-growth strands has been underestimated by between 20% and 30%.

Over time, the project results may have a significant impact on B.C.'s overall timber supply projections, reducing the size of falldowns in timber supply. In some cases, the study conclusions may support an increase in the short-term timber supply.

U.S. The model allows for implementation of various types of partial cutting and can be used for testing and development of new silvicultural systems.

- The Mixedwood Growth Model (MGM) is being modified to predict yields in boreal mixedwood types.

ECOLOGY

Ecological research provides the ministry with information to guide the management of forest resources and sustain natural ecosystem processes. This requires an understanding of the biological foundation for forest management, at both the stand and landscape levels.

Ecology research is carried out in several fields of practice, including ecosystem classification, old-growth research, riparian/wetland classification, ecosystem mapping, stand- and landscape-level biodiversity research, wildlife habitat research, range ecosystems management, and research on rare and endangered species and botanical forest products.

Ecosystem classification provides a framework for the management of timber, forage, and a variety of other forest values in B.C. Ecological research in these fields gives the ministry the information it needs to maintain forest productivity, wildlife habitat, and biodiversity. It also helps the ministry address questions and concerns raised locally and internationally about the sustainability of forest management in B.C., and about the province's adherence to international commitments.

The biogeoclimatic ecosystem classification system, which was originally developed by ministry ecologists to support silvicultural practices, has also proven valuable as a framework for other management purposes. It forms the basis for a number of the Forest Practices Code guidebooks.

Old-growth forests are a valuable commodity for the forest industry, and a highly valued natural feature. ***Old-growth research*** has been undertaken in a number of B.C. forest regions, to help address important management and conservation issues.

Silvicultural Treatment Options

With declining AACs in some areas of the province, there is renewed interest in silvicultural treatment options for improving the quantity or quality of wood fibre in B.C.'s second-growth stands. Although the use of genetically improved stock appears to be a promising avenue, decision-makers still need to quantitatively assess the impacts of tree improvement programs on growth and yield. As a first step, estimates of volume gains from improved stock were incorporated into TIPSY in 1998.

Prognosis^{BC}

Prognosis^{BC} can project the development of mixed-species coniferous stands, regardless of the structure and stage of development of the stand, as long as ground-based inventory information can define the existing structure. The model is modified from the U.S. Forest Service Forest Vegetation Simulator, which was developed in the late 1970s to support uneven-aged, mixed-species management in northern Idaho. An interim version, adapted for southeastern B.C., was released in April 1998.

Ministry research staff, collaborating with university researchers, have completed projects on the different definitions of old growth, the nature and extent of old growth in B.C., and on an approach for assessing old-growth status based on stand characteristics and stand development. Ministry researchers are also examining dead wood in forests of various ages (i.e., standing dead trees and downed coarse woody debris) to improve understanding of its ecological role. With that knowledge, researchers and managers will be able to develop forest management options that help maintain old-growth characteristics. The results will serve as a baseline in future discussions about old growth in B.C.

Coarse woody debris in an old-growth forest.

Riparian areas are key ecological elements in forest management. Under the Forest Practices Code, riparian management zones and riparian reserve zones must be established to help protect streams, lakes and wetlands. Standards for riparian zone widths and management, based on current knowledge, are included in the Forest Practices Code *Riparian Management Area Guidebook*. To help refine these guidelines, researchers are striving to better understand the ecological roles that different riparian zones play across the province, and how resource management practices affect them.

The framework for wetland and riparian classification in B.C. was produced in 1998. A draft classification for interior wetlands was also produced.

Ministry staff and industry are engaged in ***ecosystem mapping***, which assists in landscape-unit planning and improves estimates of site productivity for tree growth. Until recently, the only prescribed methodology was Terrestrial Ecosystem Mapping, which provides a reliable, functional digital map product, but this is labour-intensive and costly. More cost-effective mapping methodologies, known as Predictive Ecosystem Mapping, are now being developed. One such tool, EcoGen, will be available as an interim model by January 2000. These methods, along with results from the Site Index Biogeoclimatic Ecosystem Classification (SIBEC) project, are being applied in timber supply analysis and a variety of other processes.

Both regional and Research Branch researchers conduct ***stand- and landscape-level biodiversity research***. Projects address a variety of topics, including stand dynamics, natural disturbance patterns, wildlife habitat, rare ecosystems, and soil ecology. The information is important to maintain biodiversity at small and large scales, to formulate stand-level silviculture prescriptions, and to assist landscape-level planning – especially landscape-unit planning. The knowledge

Grizzly bears roam enormous habitat areas in search of food, so they range freely across the Canada/U.S. border in southern B.C. and the contiguous northern states For that reason, researchers from the B.C. ministries of Forests and Environment, Lands and Parks are members of international grizzly bear advisory committees.

and principles that are derived from biodiversity research have been invaluable in the development of a number of Forest Practices Code documents.

Wildlife habitat researchers provide information and advice to operations staff on silvicultural systems, wildlife-tree retention, post-harvesting prescriptions, and other management practices to maintain wildlife habitat and biodiversity. They are also developing models and identifying habitat requirements to integrate the needs of high-profile species, such as grizzly bears and caribou, into forest management plans and timber supply models.

Wildlife habitat researchers participate in a variety of land-use planning processes, including the development of Land and Resource Management Plans, landscape-unit plans, and Forest Development Plans, and on national and international scientific committees.

Range management and forage supply and allocation are important responsibilities for the Ministry of Forests. Researchers are helping the ministry meet its obligations by developing recommendations to restore fire-maintained ecosystems in dry interior zones, manage grazing in riparian ecosystems, address livestock-wildlife conflicts, and minimize the impacts of range practices on water quality.

Rare and endangered species are an important consideration in the Identified Wildlife Management Strategy, which is a component of the Forest Practices Code. Managing effectively for rare and endangered

Maintaining Biodiversity

Part of the strategy for maintaining biodiversity is creating managed forests that more closely resemble natural forests. Ecologists throughout the province are studying natural disturbance regimes and their effects on landscape patterns and stand structure. These effects vary, depending on the particular natural disturbance (e.g., wildfire, wind, insects or diseases), and can be used as models when prescribing harvesting activities.

Research results help determine the size, shape and orientation of harvesting units, as well as the characteristics of patches of trees that may be left intact within each unit. Research at the site level characterizes stand structure and the quantity and quality of dead standing trees and downed logs. This information, along with some basic principles for maintaining biodiversity, have been used to develop many of the biodiversity provisions in the Forest Practices Code, as well as other management guidelines.

Tiger salamander

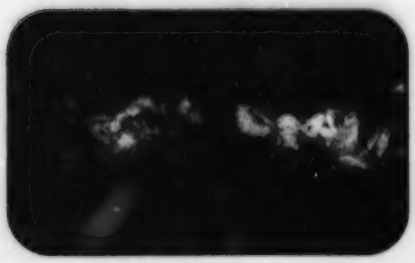
Census data and habitat maps obtained from research projects on caribou and other wildlife provide essential information for informed landscape-unit planning and operational management prescriptions.

species requires knowledge about their habitat requirements and distribution. Without adequate information, forest management runs the risk of serious negative impacts on some species, or, alternatively, of operating more conservatively than is necessary. By supporting operational staff (and being involved in joint federal/provincial committees, such as the Marbled Murrelet Recovery Team), ministry researchers play an important role in the development of management approaches to protect sensitive species.

Recent research activities have also recognized the growing importance of other forest products, in addition to timber, such as the more than 200 species of ***botanical forest products*** found in B.C. Many botanical products are now valued not only as vital elements of forest ecosystems, but as recreational and commercial assets. For example, western yew has been used in pharmaceutical preparations, and salal is widely used by the floral industry. Pine mushrooms, in particular, generate significant revenue and help diversify local economies in communities throughout British Columbia. Research projects have produced ecological descriptions and classification of highly productive pine mushroom sites. Through extension initiatives, these projects have also improved knowledge for pickers, forest licensees, and others.

Wildlife Habitat

The goal of multi-disciplinary projects in the Cariboo-Chilcotin land-use area is to develop alternative silvicultural systems that accommodate timber harvesting and planting, without jeopardizing caribou and mule deer habitats. The Northern Caribou Project includes pilot and operational-scale adaptive management blocks, and a replicated research trial. Another project is helping to define alternative silvicultural systems that can be used to maintain mountain caribou habitat. A third silvicultural systems project is investigating the size, shape and orientation of openings that will minimize the impact of harvesting on mule deer winter habitat, but still permit successful Douglas-fir regeneration and growth. In all of these projects, ministry and industry researchers are working in partnership.



Pacific golden chanterelle (Cantharellus formosus) *not only benefits trees through its mycorrhizal association with their roots, but is one the most important commercially harvested edible wild mushrooms in B.C. forests.*

EARTH SCIENCES

The objective of earth sciences research is to understand how forest management affects natural processes. This research provides the ministry with information necessary for maintaining forest productivity, water quality, fish habitat, and terrain and stream stability – all essential for sustainable forest management. Like ecology, earth sciences research helps the ministry answer local and international questions and concerns about the quality of forest management in B.C., and about B.C.'s progress on international commitments.

Earth sciences research provided the technical foundation for the development of many components of the Forest Practices Code. This research is also used in timber supply modelling, and to help ensure successful regeneration after harvesting. Working with their counterparts in silviculture and ecology, earth sciences researchers play an important role in the integrated silvicultural systems projects that have been established in most of B.C.'s forest regions.

The fields of practice under the earth sciences program include watershed hydrology, sediment movement in streams, fish/forestry interactions, soil conservation, terrain stability research, karst, and climatology.

Watershed hydrology research has been a significant activity in most forest regions for the last two decades, and an equally important Research Branch activity. Watershed hydrology studies throughout the province have contributed to development of both the Watershed Assessment Procedures for the coast and the interior, and to the *Riparian Management Area Guidebook* – two key elements in the Forest Practices Code.

Adaptive Management

Adaptive management rigorously combines the experience gained by management, research, and monitoring to provide a greater assurance of operationally meaningful results.

Range researchers started two adaptive management projects in 1998, at the request of the 100 Mile House and Invermere forest districts, and in collaboration with Forest Practices Branch. The project goal in 100 Mile House Forest District is to evaluate the impacts of grazing management on riparian areas and bird habitat. The goal in Invermere Forest District - where the project is being carried out in conjunction with an Enhanced Forest Management Pilot Project - is to address the impact of forest thinning and underburning on forage supply. Those two treatments are used to restore natural ecosystem characteristics in Natural Disturbance Type 4 ecosystems.

Servicing a tipping bucket snowmelt lysimeter.

Long-term watershed hydrology studies have been established in a number of regions to help determine the effects of forestry on different watershed components. Some of these include the timing and magnitude of streamflows, ***sediment movement in streams***, and impacts on fish habitat. The longest ongoing watershed study in B.C. is the Carnation Creek study, on western Vancouver Island, which has been in place for more than 25 years. Results from Carnation Creek were essential in the development of the Coastal Fisheries Forestry Guidelines, a product of the ***Fish/Forestry Interactions*** Program. The results have also been incorporated into the Forest Practices Code, contributing to both the *Watershed Assessment Procedure Guidebook* and the *Fish Stream Identification Guidebook*. The Stuart/Takla watershed study, a paired watershed study established more recently, is designed to evaluate the cumulative effects of the Forest Practices Code on fish habitat.

Soil conservation research in the early 1980s focused primarily on soil disturbance effects such as soil compaction and nutrient displacement. These results were used to develop the first provincial soil conservation guidelines, which were later incorporated into Forest Practices Code soil management guidebooks. Major accomplishments have included the development of a risk-rating system based on soil disturbance hazard keys, and soil disturbance measurement criteria.

More recently, soil scientists have provided technical advice to implement the soil conservation components of the Forest Practices Code. Their research in soil conservation and rehabilitation, coarse woody debris, and root rot treatments will help improve the technical foundation for Forest Practices Code standards and guidelines. Researchers have established long-term soil productivity trials to examine the effects of forest management practices on short- and long-term site productivity. Sites are located throughout B.C., so results can be extrapolated to a broad range of soil and ecological conditions. Soil ecology studies have also been established at some of the trial sites. Information from these initiatives will help refine the provincial soil conservation guidelines.

Watershed Management

A number of studies have been established in the B.C. interior to look at watershed processes and the cumulative effects of forest practices on them. The Penticton Creek Watershed Study, which was established in 1984, is a traditional paired study with a control watershed and two treatment watersheds. Component studies are being done on water chemistry, channel stability, aquatic invertebrates, streamflow, sediment delivery, and water balance. After many years of collecting baseline data, logging – and monitoring of that logging – is underway.

The West Arm Demonstration Forest is the site of sediment monitoring, watershed modelling, and snowline studies. Results from these studies, and from others in the interior, will help refine the *Watershed Assessment Procedure Guidebook* and guide those who make professional recommendations on watersheds.

Researcher excavating peat in a paleoflowslide study.

The summer harvesting of aspen and conifer mixtures on sensitive soils is a significant management issue that is being addressed by the boreal Long-Term Soil Productivity Study.

Terrain stability research has supported the development of terrain mapping standards and slope stability assessments under the Forest Practices Code. Forest Science researchers in a number of forest regions have also contributed to the information base that supports the terrain requirements of the code.

Landslides can affect fish habitat, site productivity, road construction and maintenance costs, timber access, and visual quality. Under the code, slope stability classes must be used during terrain analysis to delineate areas where it is safe to operate machinery from those where it is not (i.e., inoperable areas), and to help prescribe logging and road-building techniques.

Eleven years ago, researchers started a terrain analysis study of forest-management – induced landslides on the coast. The results of the study, which collected samples from more than 4,000 terrain units and data from hundreds of different landslides, formed the basis for the development of slope stability classes. In the last two years, researchers have collected additional data from northern Vancouver Island, and completed a terrain attributes study to characterize interior slopes in the Nelson Forest Region.

Karst research examines ecosystems that have developed on soluble limestone bedrock. These ecosystems feature a porous landscape, often riddled with caves, which supports unusual plants and animals and can be very productive for tree growth. But what makes these systems hydrologically unique – their extensive underground cave systems, which act as conduits for water – also makes them extremely sensitive to forest management practices. In B.C., the highest-profile karst systems are on the northern end of Vancouver Island, which is renowned for its coastal temperate old-growth rain forest.

Riparian Management

Riparian research examines physical and biological processes adjacent to streams. Studies are looking at the role played by large woody debris in stream channel processes, as physical barriers to water flow. Large woody debris in streams also is being studied in many biogeoclimatic zones, to determine how its role in stream channel processes changes from one zone to another, and in different sizes of streams. Stream temperature changes as a result of the removal and growth of vegetation are being monitored in the Cariboo and Prince Rupert forest regions. This research will help resource managers formulate site-specific riparian management plans and define optimum tree retention targets for different stream classes.

Staff from the Vancouver Forest Region, the Forest Practices Branch and the Research Branch are part of a joint effort to produce karst inventory standards and management guidelines.

In 1998/99, interim karst inventory standards were developed and reviewed by ministry staff, members of the Resources Inventory Committee, and international karst experts. Work continues to test and refine the proposed guidelines, before finalizing them as official Resource Inventory Committee standards.

Climatology researchers provide technical support for a range of scientific investigations, as well as advice and services to support the ministry's national and international commitments to control the emission of greenhouse gases, such as carbon dioxide and methane. In 1998/99, climatologists collaborated with regional researchers on silvicultural systems research sites, with hydrologists on the effects of logging on watershed response, and with soil scientists on long-term soil productivity sites. Ministry climatologists are currently researching the potential impacts of future climate change on forests and forest management.

The ministry is also actively involved in developing a national strategy on climate change. In December 1997, Canada and other nations adopted the Kyoto Protocol to limit emissions of greenhouse gases. The ministry will participate with other governments, industry, and environmental organizations to analyze and evaluate issues related to implementing the protocol in the forest sector.

Sinks Issue Table

Ministry climatologists are participating in the Sinks Issue Table in support of Canada's commitment under the Kyoto Protocol. The table will identify the status of current knowledge, information gaps, and challenges on the issue of biological sinks as they relate to forestry and agriculture.

The outcome of this process could have a major impact on forestry in B.C. The table also provides technical input and advice to the federal and provincial governments, to help Canada develop a negotiating position on the sinks issue which reflects the unique nature of our forests and agriculture.

FOREST GENETICS

British Columbia enjoys a wealth of native tree species, each with tremendous levels of genetic diversity, growing across a wide variety of environments. That creates a significant challenge for effective gene resource management. At the same time, however, it presents a unique opportunity to forestry for increasing timber production, through the sound application of plant breeding principles.

The fields of practice under the forest genetics program include tree breeding, forest genetics research and management, and gene conservation.

Tree breeding captures and utilizes natural genetic diversity by identifying parent trees that are of good form, pest resistant, and naturally fast-growing, then testing the performance of their offspring in scientifically designed field trials (i.e., progeny tests). The parent trees with the fastest-growing progeny are selected and used in seed orchards. Their seeds, or vegetative cuttings from selected parents, are then used for reforestation. Genetic gains can be estimated and forecast for various rotation ages. Further selections within these progeny trials provide future parent trees for advanced generation breeding and orchards.

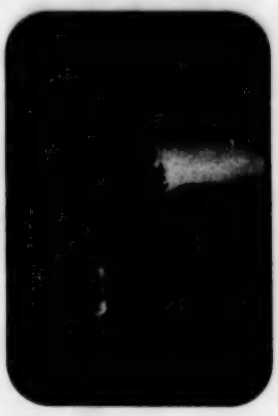
Currently, there are breeding programs for 10 commercial conifer species in B.C. Industry and the ministry's seed orchards depend on these breeding programs, which have been developed and are maintained by the Research Branch, to establish commercial production of genetically improved seeds.

Insect and Disease Resistance The primary approach to breeding for insect and disease resistance relies on the identification and selection of naturally resistant trees. This can be done either through screening trials, or through surveys in forest stands where the disease or pest is present at high densities. Parallel lines of research are the study of mechanisms of resistance and better understanding of the biology of the pest or disease. Weevils in Sitka spruce and white spruce, and blister rust in western white pine have limited the use of these species for reforestation in B.C. The Research Branch, in a variety of partnerships, is working to develop resistance in these three important tree species.

Assuring the genetic quality of seed orchard seeds, and transferring and deploying genetically improved seeds, vegetative cuttings (i.e., propagules) and other propagation materials are critical to the health of the forest industry now and in the future. ***Forest genetics research and management*** provides the knowledge that is needed for developing sound seed transfer guidelines, deployment strategies, and orchard seed quality assurance.

Western Hemlock Breeding Program

Forest Science Program geneticists have worked with existing western hemlock breeding programs in Oregon and Washington, and utilized tested parent material by forming HemTIC, a joint effort within the Northwest Tree Improvement Cooperative. In just five years, researchers have completed all second-generation crossing and established new plantations with the progeny. Second-generation selections will take place in approximately 10 years. Recent advances have included establishing new low-elevation hemlock seed orchards, and screening for wood properties such as fibre coarseness and extractive content.



Resistant (left) and non – blister-resistant white pine (right)

Deployment strategies are based on theoretical models that have been tested using empirical data. Other research topics, such as population and provenance studies, molecular genetic markers, somatic embryogenesis (a cloning technique) field testing, root and crown management of orchard trees, and pollen biology and management, all contribute to this important part of the forest genetics program.

Cone Induction and Pollen Management In cooperation with industry and Ministry of Forests seed orchardists on the coast and in the interior, the Research Branch has developed operational procedures from applied field research on cone (i.e., conifer flower) induction and pollen management. These procedures are now routinely applied in seed orchards to enhance orchard seed production and improve seed quality. This knowledge is also applied in seed production studies of western larch and true fir species growing in partial cuts. The goal is to increase natural stand seed production and, ultimately, natural regeneration, especially at high elevations.

The objective of ***gene conservation*** is to develop programs that will maintain the existing levels of natural genetic diversity for species affected by all levels of forest management. The vehicles for gene conservation are combinations of *in situ* populations (e.g., parks and reserves), and the many *ex situ* populations (e.g., test and breeding material, clone banks, and seed storage facilities) in the forest genetics program. The integration of all of these genetic resource levels is fundamental to the development of wise conservation strategies, but will vary depending on the species.

Ministry researchers have completed a survey of the currently protected genetic resources of 23 native conifer species in B.C. and developed a framework to quantify the presence of specific genes in various conservation populations. This scheme could have significant applications to world-wide gene conservation efforts. Researchers have also identified further work. It includes updating and verifying

Mature Douglas-fir pollen buds

Provenance Transfer

Provenance transfer refers to the movement of seeds from their exact place of origin. Traditionally, it has been guided by physical attributes (e.g., latitude and longitude) and by indicators of habitat environment. But this approach assumes that environmental conditions associated with the current natural habitat will not change.

A more dynamic approach that is now being considered links provenance transfer to climatic variables (e.g., the frost-free period, or the amount of precipitation during the growing season), but requires adequate sampling of both provenances and provenance testing environments. There has been extensive provenance testing on three species: lodgepole pine, Sitka spruce, and coastal Douglas-fir. Results for central B.C. so far suggest that, if global warming scenarios are true, growth loss will be 30% to 55% if presently adapted populations remain in their current locations. This research will be critical in determining the boundaries of future seed planning zones.

existing *in situ* reserves, fostering cooperation with international gene conservation programs, and defining *in situ* and *ex situ* populations that make up the breeding and testing program.

EXTENSION AND COMMUNICATIONS

Scientific knowledge has limited value until it reaches those who apply it – the end users. Linking scientific information providers with end users is the primary function of extension and communications, and all members of the Forest Science Program are partners in that process.

Extension and communications uses a range of methods and tools to share knowledge with the science and forest resource management communities, and with the public. Extension methods include personal contact (e.g., providing consultations, workshops and field tours, and participating on advisory and technical review boards), and contributions to printed and Internet-based materials (e.g., Forest Practices Code guidebooks, extension notes and reports, forest policy and regulations, and standards for implementing forest policy legislation). Tools include computer models, software, maps and field guides.

Extension and communications also provides other services that support research activities. For example, staff at the Ministry of Forests and other ministries make extensive use of technical consultation in biometrics, and the Analytical Chemistry Laboratory analyzes plant tissue, soil and water samples in support of a wide range of research projects.

In response to recommendations made in the *Ministry of Forests Research Branch Five-Year Strategic Plan* (October 1998), extension and communications is now working on an even broader delivery of information, by emphasizing forest sciences collaboration in extension partnerships, and by expanding its website.

Biometrics

The Biometrics Section of the Forest Science Program advises on research project design and analysis. Recent examples are the Long-Term Soil Productivity Study, the Date Creek Experimental Forest, the Roberts Creek Study Forest, and the Sicamous Creek Project.

Some examples of how statistical expertise provided by the section in 1998/99 helped Forest Service operational staff include:

- proposing an improved new sampling scheme for the Vegetation Resource Inventory,
- examining how to properly use inventory audit data for timber supply analysis,
- modelling the error in forest inventory data to improve the reliability of timber supply projections using the spatial timber supply analysis model,
- recommending how to make the scaling system's weight scale sampling method more cost-effective without compromising statistical reliability, and
- correlating the ability of silviculture surveys to correctly identify sufficiently restocked or free-growing sites with the expected yields as projected by TASS for those sites. This work is being done for lodgepole pine and will form the basis for assessing the current parameters of silviculture surveys.

VISION FOR THE FUTURE:

MESSAGE FROM THE DIRECTOR

The Forest Science Program underwent an extensive review in 1998/99. The review revealed that the program was in danger of becoming static and too inward-looking, and of losing the innovation and vision needed to maintain leading-edge science. The strategic review process forced us to examine our resources and priorities, and to explore new ways to meet today's realities and challenges. The resulting vision will guide our way of doing business and how we deliver our product to serve a range of clients, from operational field staff to executive policy-makers.

Implementing this new direction depends on an internal culture that embraces change. We are committed to an annual re-evaluation of our priorities, and to being constantly alert for opportunities to enhance our effectiveness. But we also must not lose sight of the other cornerstone of a credible research program – commitment to long-term projects. Therein lies a major challenge: how to balance the dedication to credible long-term research with short-term demands for solutions to pressing management issues.

CHANGING HOW SCIENCE IS DELIVERED

A great deal has already been done to make research projects more inter-disciplinary, and to ensure that comprehensive solutions to emerging issues remain a priority. We still need to give additional emphasis to incorporating milestones into research designs and encouraging early reporting, particularly of results that address current management challenges. In the same way, existing knowledge and new findings must continue to be synthesized and communicated, to give decision-makers the best and most relevant information as quickly as possible.

This is being achieved, in part, by a significant recent shift in the role of Forest Science Program researchers. They are now devoting more attention to pressing operational and policy issues, to close the gap between science and management. This is being supported by the development of an internal culture that places a priority on providing scientific advice and support, and on participating in working groups and on special task teams.

The program will undergo significant management changes in the 1999/00 fiscal year. The *Ministry of Forests Research Branch Five-Year Strategic Plan* that was completed in October 1998 identified the importance of strong leadership in setting program direction. The plan also highlighted the need for greater priority on some elements of research policies and procedures, especially data custodianship and management, experimental design standards, project planning procedures, review and reporting standards, communications and extension, and research scientist career development.

BUILDING PARTNERSHIPS

On a broader scale, cooperation among all science providers must be improved. Currently, limited forest science funding from various sources is parcelled-out among government agencies, universities, industry, interest groups, and other agencies throughout British Columbia. A pivotal challenge for the future is to develop a forest sciences strategy that sets clear directions for all forest science providers, and productively allocates resources to avoid program fragmentation, overlaps, gaps, and unnecessary competition.

The first steps in meeting this challenge have already been taken: the Committee of Forest Research Agencies of B.C. (COFRA) has been reactivated, and liaison and cooperation among science providers is being actively promoted through joint projects and informal partnerships. COFRA joins science providers across Canada in advocacy and information exchange through the national Forest Sector Coalition for the Advancement of Science and Technology (FORCAST). Creating the southern interior and the northern forest extension and research partnerships has provided regional mechanisms for integrating scientific work.

SUPPORTING THE MINISTRY'S FUTURE DIRECTIONS

In support of the ministry's strategic priorities, the Forest Science Program will continue to improve the productivity and management of forest resources and provide a solid scientific foundation for forest practices. It will also contribute to the ministry's goal of fostering a globally competitive forest industry.

Research related to long-term timber supplies will continue to be the largest component of the Forest Science Program in the immediate future. Projects in genetics and tree breeding are utilizing financial resources from the Forest Renewal BC research and operational tree improvement programs to respond to goals set by the British Columbia Forest Genetics Council. Projects include developing and implementing sound policies for gene management and conservation, and, by 2007, significantly enhancing the genetic worth of new plantations of major tree species.

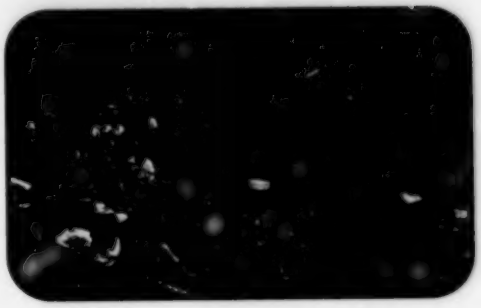
The improvement of long-term timber supplies is also supported by research on forest productivity and alternative silvicultural systems, with guidance from the Forest Productivity Council of British Columbia. Once current program commitments to multi-year silviculture projects funded by Forest Renewal BC are completed, the focus will shift to studying the effects of silvicultural systems options on forest productivity, particularly in mixedwood and uneven-aged stands, and under partial cutting regimes. Growth and yield modelling will continue to define and incorporate forest responses to new management treatments.

Ecosystem integrity is not only fundamental to stewardship of forest resources, it is also an increasingly important factor in British Columbia's competitive position in the global forest products market. Ministry ecology and earth sciences activities, in particular, will be invaluable as market pressure increases for certified wood products, and as international scrutiny of forest practices continues.

In the immediate future, researchers will refine the ecological classification system and develop additional applications to guide forest management practices. To support ecosystem-based management, the emphasis will be on incorporating ecological principles into resource planning activities at the landscape or

watershed level. Long-term projects, such as the Long-Term Soil Productivity Study and the Carnation Creek watershed project, will remain central components of earth sciences research, providing both short- and long-term results to assist forest managers. Earth sciences will also contribute to addressing global issues, such as climate change and maintaining biodiversity.

MAKING IT WORK



Science provides the Ministry of Forests with the ability to meet ever-increasing demands for credible, technically sound management of British Columbia's forest and range resources. As an integral part of an operational organization, the Forest Science Program will continue to address forest management issues and develop and apply scientific knowledge in solving them.

Henry Benskin, RPF
Director, Research Branch

HOW TO CONTACT US

We welcome your comments and questions about the Forest Science Program at the Ministry of Forests, and invite you to contact us by telephone, mail, fax or email. Or visit our websites for a list of publications, project summaries, and other information.

Additional copies of this report may be downloaded from the Research Branch website, or by writing to the Research Branch at the address below.

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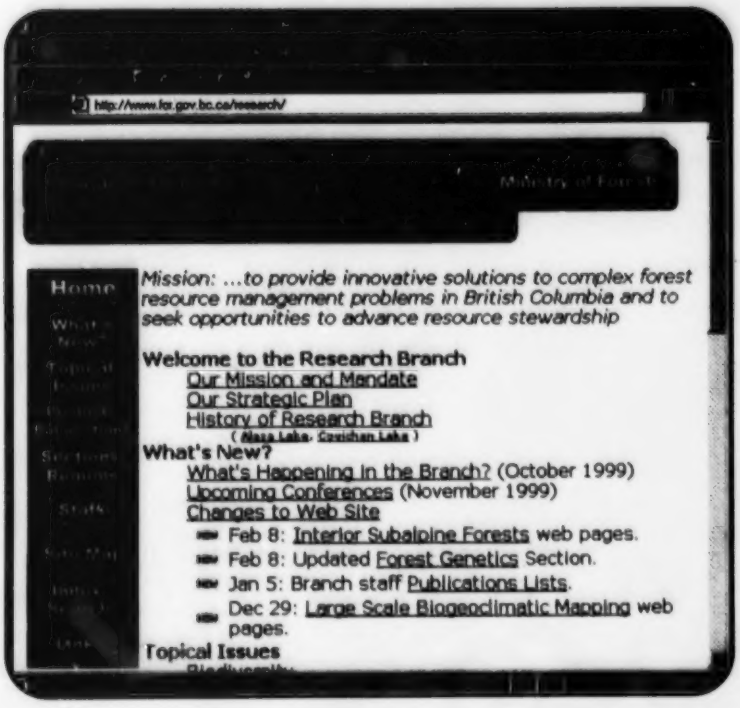
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Home
Mission: ...to provide innovative solutions to complex forest resource management problems in British Columbia and to seek opportunities to advance resource stewardship
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